

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have incorporated the subject matter of claims 3 and 21 respectively into claims 1 and 2; and, accordingly, have cancelled claims 3 and 21 without prejudice or disclaimer.

In addition, Applicants are adding new claims 41-46 to the application. Claims 41 and 44, dependent respectively on claims 1 and 2, recite that the ratio of amount by weight of the acid to the amount by weight of the oxidizing agent is in a range of 1.0-100; and claims 42 and 45, dependent respectively on claims 41 and 44, further define this ratio. Claims 43 and 46, dependent respectively on claims 1 and 2, recite that amount of the fluorine compound in the solution is 0.001-15% by weight.

In connection with the newly added claims, note, for example, the paragraph bridging pages 6 and 7, and the second full paragraph on page 8, of Applicants' specification.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed March 7, 2006, that is, the teachings of the U.S. patent documents to Gotoh, et al., No. US 2002/0066465, to Skee, No. US 2002/0077259, to Kim, et al., No. US 2004/0038839, to Matsuo, et al., No. 6,296,714 and to Luo, et al., No. 6,524,168, under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a cleaning solution, or such process for cleaning semiconductor substrates using such cleaning solution, as in the present claims, the solution having components as recited in the present

Docket No. 396.43501X00

Serial No. 10/777,085

July 7, 2006

claims, including an oxidizing agent and an acid, and wherein a ratio of an amount by weight of the acid to an amount by weight of the oxidizing agent is in a range of 0.1-1,000 (note claims 1 and 2); more specifically, wherein such ratio is in a range of 1.0-100 (see claims 41 and 44), or even more specifically, in a range of 1-60 (see claims 42 and 45).

In addition, it is respectfully submitted that the applied references would have neither disclosed nor would have suggested such a cleaning solution, having features as discussed previously in connection with claims 1 and 2, and, moreover, wherein the solution also includes a corrosion inhibitor. See claim 2.

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such cleaning solution as in the present claims, having features as discussed previously in connection with claims 1 and 2, and also having other features of the present invention as in the remaining claims being considered on the merits in the present application, including (but not limited to) the further definition of materials of the oxidizing agent, and/or acid, and/or fluorine compound, as in claims 4-11 and 22-31; and/or amount of fluorine compound as in claims 43 and 46; and/or further definition of the basic composition added to adjust the pH range, as set forth in claims 12, 13, 32 and 33; and/or wherein the corrosion inhibitor is polyethyleneimine (see claim 14); and/or wherein the solution further includes a surfactant (see claims 15 and 34), in particular the further definition of the surfactant as in claims 16, 17, 35 and 36; and/or wherein the solution is adapted for cleaning semiconductor substrates having metal wiring which includes copper alone or a laminate structure of copper and a barrier metal (see claims 18 and 38).

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

Furthermore, even assuming, arguendo, that the applied prior art would have established a prima facie case of obviousness, the evidence of record in Applicants' specification (note especially the Examples and Comparative Example 2, discussed infra) shows unexpectedly better results achieved by the present invention, and clearly establishes unobviousness of the presently claimed subject matter.

The present invention relates to a cleaning solution for removing substances attached to the surface of semiconductor substrates, and a process for cleaning using such solution. Such solution can remove substances strongly attached to the surface of semiconductor substrates without damaging metal wiring and interlayer insulation films on the semiconductor substrate.

In present-day semiconductor processing, lithography is used as a process for producing wirings and patterned insulation films on a substrate such as a silicon wafer. In such lithography, a patterned resist is used as a mask, and a desired pattern is formed on a layer below the patterned resist; thereafter, the patterned resist is completely removed.

In forming the desired pattern in the layer below the resist layer, e.g., by dry etching, residues derived from the dry etching gas, the resist, the film being patterned and other materials in the chamber of the dry etching apparatus, are formed, and must be removed utilizing, e.g., a cleaning solution. Various previously utilized cleaning solutions are described on page 2, lines 18-23, page 3, lines 6-11, and in the paragraph bridging pages 3 and 4, of Applicants' specification. However, these previously proposed cleaning solutions have various problems, as described in the paragraph bridging pages 2 and 3, and the paragraph bridging pages 3 and 4, of Applicants' specification.

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

Against this background, Applicants provide a cleaning solution, and method of use thereof, which can be used to completely remove etching residues without damaging the wiring materials (for example, without corrosion thereof), which is safe, and which exhibits reduced adverse effect on the environment. Applicants have found that by utilizing a cleaning solution which includes an oxidizing agent, an acid and a fluorine compound, and which has a pH adjusted in a range of 3-10 by addition of a basic compound, the concentration of water in the solution being 80% by weight or greater, and wherein a ratio of an amount by weight of the acid to an amount by weight of the oxidizing agent is in a range of 0.1-1,000, objectives according to the present invention are achieved; and, in particular, a cleaning solution for semiconductor substrates is achieved which can completely remove etching residues without adverse effect (e.g., without corrosion) on, e.g., wiring on the semiconductor substrate, and which is safe and has little adverse effect on the environment.

In particular, by adjusting concentrations (amounts) of the oxidizing agent, the acid and water as in the present claims, etching residues can be efficiently removed, and corrosion of wiring materials can be effectively suppressed. See, for example, page 7, lines 12-14, of Applicants' specification.

Furthermore, by utilizing a concentration (amount) of fluorine compound as in, e.g., claims 43 and 46, etching residues can be efficiently removed, while corrosion of wiring materials can be avoided.

Furthermore, with pH of the cleaning solution in the range recited in the present claims, etching residues can be efficiently removed. Note, for example, page 11, lines 22-25, of Applicants' specification.

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

As to advantageous results achieved according to the present invention, attention is respectfully directed to the Examples and Comparative Examples on pages 13-23 of Applicants' specification. Note, in particular, Comparative Example 2 in Table 3 on page 17, as compared with Examples within the scope of the present invention. It is respectfully submitted that the composition of Comparative Example 2 corresponds to disclosure in the applied reference of Gotoh, et al., in having a ratio of acid to oxidizing agent of 0.02, as discussed further infra. As can be seen in Table 3 on page 17 of Applicants' specification, the removal of etching residues in Comparative Example 2 was only "fair". It is respectfully submitted that the evidence in Applicants' specification shows unexpectedly better results achieved according to the presently claimed subject matter, including ratio of amount by weight of the acid to amount by weight of the oxidizing agent, clearly supporting unobviousness of the presently claimed subject matter. In this regard, it is respectfully submitted that this evidence in Applicants' specification must be considered in determining patentability of the presently claimed subject matter. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984).

Gotoh, et al. discloses a cleaning method for removing deposits on a surface of a material to be treated, without damaging the material to be treated, the composition including an oxidizing agent, a chelating agent and a fluorine compound, which composition flows on a surface to be treated at a high speed to thereby clean the surface to remove residues on the surface. See paragraph [0010] on page 2 of Gotoh, et al. Note also paragraphs [0017] and [0018] on page 2 of Gotoh, et al., respectively further defining the oxidizing agent and chelating agent; and paragraph [0020] on page 2, defining amount of chelating agent included in the cleaning agent. Note also paragraph [0021] on page 3 of Gotoh, et al., further

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

defining the fluorine compound and amount thereof. Gotoh, et al. also discloses that the pH of the cleaning solution shall not specifically be restricted, and is usually used in a range of pH 3-12; and that when the cleaning solution is used in an alkaline condition, ammonia, amine and quaternary ammonium hydroxides may be added, and when it is used in an acidic condition organic acids and inorganic acids may be added. See paragraph [0026] on page 3 of Gotoh, et al.

As seen in the foregoing, as well as from a full review of this reference, it is respectfully submitted that this reference does not disclose, nor would have suggested, such cleaning solution as in the present claims, or method of use thereof, including ratio of amount by weight of the acid to that of the oxidizing agent.

In connection with this ratio, the Examiner contends in the first full paragraph on page 5 of the Office Action mailed March 7, 2006, that the teachings of Gotoh, et al. "would suggest a ratio of acid to oxidant" (emphasis added) as in present claims 1 and 2. Initially, it is respectfully submitted that the assertion by the Examiner that the teachings of Gotoh, et al. would "suggest" such ratio is inconsistent with a rejection under 35 USC 102. That is, in order to anticipate the presently claimed subject matter, it is respectfully submitted that the teachings of the reference must describe the claimed subject matter, not merely "suggest" the claimed subject matter.

In any event, it is respectfully submitted that, as shown in the following, the teachings of Gotoh, et al. would not have disclosed or suggested a ratio of acid to oxidant as in the present claims. Thus, it is noted that the Examiner has pointed to no evidence or reasoning as a basis for the assertion that the teachings of Gotoh, et al. would "suggest" the recited ratio of acid to oxidant. Without evidence or reasoning in support thereof, the basis for the rejection is improper. See In re McKellin, 188 USPQ 428 (CCPA 1976).

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

In addition, it is noted that Gotoh, et al., at paragraph [0017] on page 2 thereof, discloses that the oxidizing agent used has a content of 0.0001-60% by weight based on the cleaning agent, and also at paragraph [0020] describes that the chelating agent has a content of 0.01-10% by weight based on the cleaning agent. However, Gotoh, et al. does not disclose a ratio of chelating agent to oxidizing agent. In this connection, for example, calculation of the ratio of chelating agent to oxidizing agent according to Tables 1 and 2 in Gotoh, et al. provides ratios of 0.03 and 0.04, outside the scope of claims 1 and 2. It is respectfully submitted that Gotoh, et al. would have neither taught nor would have suggested the presently claimed subject matter, including ratio of amount of acid to amount of oxidizing agent, and advantages thereof in removal of etching residues.

While the Examiner has discussed previously considered claims 3 and 21 in the paragraph of the Office Action mailed March 7, 2006, relating to the anticipation rejection, the Examiner specifically rejected claims 3 and 21 under 35 USC 103(a). In connection therewith, the Examiner concludes that the broad teachings of Gotoh, et al. "suggest a cleaning composition" having, inter alia, "the other requisite components of the composition in the specific amounts as recited in the instant claims". The Examiner provides no evidence or reasoning in support of this conclusion with respect to "the broad teachings" of Gotoh, et al. Such conclusion by the Examiner, without evidence or reasoning in support thereof, is clearly improper (see In re McKellin, supra), especially in light of the unexpectedly better results achieved according to the present invention, as established by the evidence in Applicants' specification.

It is respectfully submitted that the secondary references as applied by the Examiner would not have rectified the deficiencies of Gotoh, et al., such that the

Docket No. 396.43501X00

Serial No. 10/777,085

July 7, 2006

presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Skee discloses compositions useful in the microelectronics industry for cleaning semiconductor wafer substrates, the compositions containing one or more metal ion-free bases dissolved in water in sufficient amount to produce a pH of about 10 or greater and a bath stabilizing effective amount, generally about 0.1% to about 50% by weight, of at least one bath stabilizing agent including at least one compound with at least one pKa in a range of 10-13. Note especially paragraphs [0026]-[0030] on pages 2 and 3 of Skee. See also paragraph [0031] on page 3 of Skee, describing that the compositions may contain other components such as silicates, chelating agents, organic solvents and surfactants. See also paragraphs [0042] and [0043] on pages 4 and 5 of Skee, describing various chelating agents. Note also paragraphs [0044] and [0045] on page 5 of Skee.

Even assuming, arguendo, that the teachings of Skee were properly combinable with the teachings of Gotoh, et al., such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including, inter alia, ratio of amount by weight of acid to that of oxidizing agent as in the present claims, and advantages thereof.

With respect to the subject matter of claims 5 and 23, attention is respectfully directed to the teachings of Kim, et al. and Matsuo, et al.

Kim, et al. discloses an organic stripping composition and an etching method using the same, the organic stripping composition including a compound containing a hydroxyl ion, a compound including fluorine ion and a sufficient amount of an oxidizing agent to control the pH of the composition to within the range of from about

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

6.5 to about 8.0. Note paragraph [0023] on page 2 of Kim, et al. Note also paragraphs [0025], [0026] and [0040] on pages 2 and 3 of Kim, et al.

Initially, it is noted that Kim, et al. is directed to an organic stripping composition. It is respectfully submitted that one of ordinary skill in the art concerned with in Gotoh, et al. would not have looked to the organic stripping composition of Kim, et al.

In any event, even assuming, arguendo, that the teachings of Gotoh, et al. and Kim, et al. were properly combinable, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including, inter alia, the above-described ratio, and advantages achieved thereby.

Matsuo, et al. discloses a washing solution for washing the surface of a semiconductor substrate such as a silicon wafer, the washing solution containing 0.0001-0.1% by weight of an organic acid and 0.005-0.25% by weight of hydrofluoric acid and having a pH of 2-4. See column 2, lines 39-43. As for the organic acid, note column 2, lines 44-50.

Even assuming, arguendo, that the teachings of Matsuo, et al. were properly combinable with the teachings of Gotoh, et al., such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including the above-described ratio of amount of acid to amount of oxidizing agent, and advantages thereof.

Insofar as applied in connection with present claim 14, Luo, et al. discloses compositions that are useful as polishing compositions for chemical-mechanical polishing of semiconductors, the compositions being aqueous and including an oxidizing agent such as an alkali metal chlorate or hydrogen peroxide, an inhibitor of a polyalkyleneimine, and a pH buffer such as ammonium phosphate or an alkali

Docket No. 396.43501X00

Serial No. 10/777,085

July 7, 2006

metal carbonate, and, optionally, a complexing agent, oxide suppressants and other inhibitors. See column 1, lines 52-62. Note also column 2, lines 30-34.

Initially, it is noted that Luo, et al. is directed to a composition for chemical-mechanical polishing. It is respectfully submitted that one of ordinary skill in the art concerned with in Gotoh, et al., directed to a cleaning technique, would not have looked to the chemical-mechanical polishing composition of Luo, et al.

In any event, even assuming, arguendo, that the teachings of these applied references were properly combinable, such combined teachings would have neither taught nor would have suggested the presently claimed cleaning solution, including, inter alia, the discussed ratio of amount of acid to amount of oxidizing agent, and advantages achieved by the present invention having such feature.

Applicants respectfully direct the Examiner's attention to the withdrawn claims, that is, claims 19, 20, 39 and 40, directed to a method of use of the cleaning solution. Upon allowance of claims directed to the solution, it is respectfully requested that the Examiner reconsider and rejoin the method claims, since where the claims directed to the cleaning solution are allowable the use of such cleaning solution as in the present process claims must also be allowable.

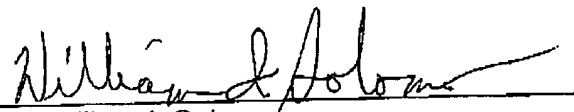
In view of the foregoing comments and amendments, allowance of all claims presently in the above-identified application, both those directed to the cleaning solution and those directed to the process of use thereof, are respectfully requested. At least, reconsideration and allowance of the claims being considered on the merits in the above-identified application are respectfully requested.

Docket No. 396.43501X00
Serial No. 10/777,085
July 7, 2006

Applicants request any shortage in fees due in connection with the filing of this paper be charged to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case 396.43501X00), and credit any excess payment of fees to such Deposit Account.

Respectfully submitted,

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